EXPERIMENT MANUAL

KIDS FIRST

INTRO TO ENGINEERING

SCIENCE KIT

THAMES & KOSMOS

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››› SAFETY INFORMATION

⚠ **WARNING:**
CHOKING HAZARD — Small parts. Not for children under 3 yrs.

WARNING! Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long cords may become wrapped around the neck.

Store the experimental kit out of reach of young children.

Keep the packaging and instructions as they contain important information.

WARNING! The model boats are only to be used in water in which the child is within its depth and under adult supervision.

Rules for safe experimentation

- Keep children and animals away from the experimental area.
- Do not eat or drink in the experimental area.
- After the experiments, the used pieces of equipment should be rinsed, dried with paper towel, and put back in their spots in the experiment kit. The worktable should be wiped off and hands should be washed.
- Be careful not to hit people with the parachute or the helicopter.
- Do not throw the glider toward anyone. Do not aim at eyes or face.

››› IMPORTANT INFORMATION

Dear Parents,

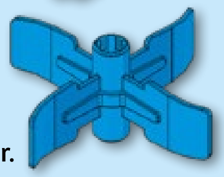
Children are curious by nature. They want to explore and understand the world. With this experiment kit, even five-year-olds can carry out their first exciting experiments. Experimenting, wondering, and playing are all tied together, so they won't miss out on fun while they learn. In the process, they will develop an understanding of the fundamentals of engineering, and they will discover how fun it can be to do experimental research.

The experiments are easy, but they won't work without a little effort. Give support to your little explorers, since children's curiosity and ability to understand things are often more fully developed than their manual capabilities. And if an experiment doesn't work right the first time, encourage your child to try the experiment one more time.

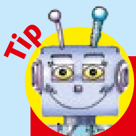
If an experiment is marked with this symbol it means that your help will be required to make sure it is safe and successful.

Help your child find a well-lit location that can take a little wear and tear, where you can both do the experiments without being disturbed. As with real researchers, it is advisable to wear old clothes that you won't mind getting dirty. We also recommend that you have all the experimental materials ready beforehand, so it won't be necessary to stop in the middle of an experiment to get something. Because this kit was designed for young researchers, the descriptions and explanations have been kept as short and simple as possible. They should be organized and read together beforehand, so that the children can do the experiments independently with a solid understanding of the background knowledge.

The correct alignment of the components is important! Paying close attention to this from the beginning will make building the models easier.



We wish you happy experimenting!



= Cutting line
= Gluing surface
= Line remains visible on outside when folded
= Line disappears on the inside when folded

››› KIT CONTENTS

GOOD TO KNOW!
››› If you are missing any parts, please contact Thames & Kosmos customer service.

Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
❍	1	Flip-book paper sheet	1	724 431
❍	2	Printed paper sheet	1	725 111
❍	3	Glider paper sheet	1	724 432
❍	4	Die-cut sheet (10 parts)	1	724 430
❍	5	String	1	724 057
❍	6	Drinking straw black	2	724 045
❍	7	Pipette	1	724 048
❍	8	Parachute sheet	1	724 047
❍	9	Rubber band	4	724 046
❍	10	Paddle wheel	1	706 540
❍	11	Paddle wheel axle	1	706 803
❍	12	Boat hull	2	716 691
❍	13	Part separator tool	1	702 590
❍	14	Small frame	1	721 902
❍	15	15-hole dual rod	2	715 676

✔	No.	Description	Qty.	Item No.
❍	16	5-hole rod	2	716 875
❍	17	3-hole rod	2	714 125
❍	18	Medium gear	2	719 601
❍	19	Small pulley wheel	2	707 011
❍	20	Medium pulley wheel	2	706 852
❍	21	O-ring for medium pulley	2	703 251
❍	22	Axle, 70 mm	2	713 490
❍	23	Axle, 30 mm	1	716 860
❍	24	Crane hook	1	706 533
❍	25	Spool	1	706 854
❍	26	Anchor pin, red	8	702 527
❍	27	Button pin, white	4	714 329
❍	28	Short anchor pin, black	4	721 921
❍	29	Shaft plug	2	718 133
❍	30	Joint pin	2	717 768

Any materials not included in the kit are marked with this symbol ✚ under the “You will need” heading.

You will also need:
Paper, pen, glue, scissors, coin, glass, mixing bowl, two small empty yogurt cups, 2 cooking spoons, thin rope, paper towels, water, sink, bathtub, long wooden board for ramp, books, toys like building blocks, marbles, toy figures

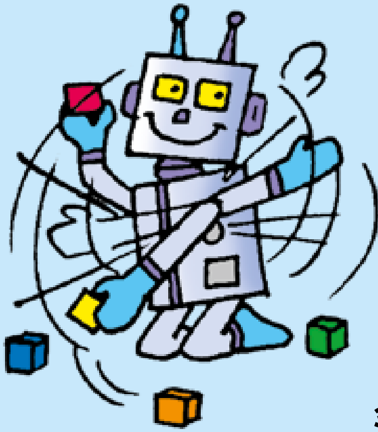
››› TABLE OF CONTENTS

Dear Kids!

Are you interested in machines and technology? Do you want to know how vehicles work — on land, in the water, and in the air? And have you always wanted to build a robot? Then let's get serious about engineering!

Your parents will be happy to help you gather the extra things you might need for each experiment, perform each step of the experiment, and read the explanations afterward. Make sure you follow the instructions closely. The tips will help you with the trickier building steps. Don't be frustrated if something doesn't work as expected the first time: That is an important part of science!

Let's start our experiments by examining levers! Have fun!



What Is Engineering?

Engineering is the use of scientific knowledge for designing and building things. A person who studies or practices engineering is called an engineer. Engineers plan and build everything from machines to specific materials, from giant structures to microscopic devices, from manufacturing systems to software programs on computers.

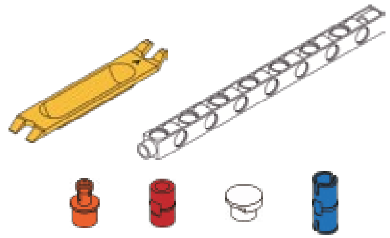
There are six main branches of engineering. Mechanical engineers work on physical systems and machines, like engines and buildings. Civil engineers work on large infrastructure projects, like highways and bridges. Chemical engineers work with all sorts of materials and substances. Aerospace engineers design airplanes and spacecraft. Electrical engineers work on devices that use electricity, like computers. Software engineers write computer programs.

In this kit, we have divided the projects into sections based on location: projects on land, in the air, in the water, and at home. There is also one experiment about high-tech robotic engineering, just for fun. But first, let's start with some technical tricks that make tasks easier!

EXPERIMENT 1

Lever

YOU WILL NEED



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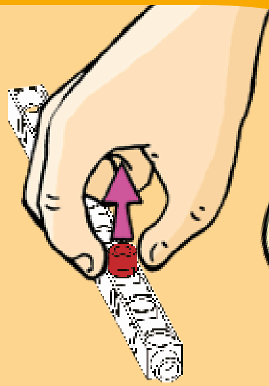

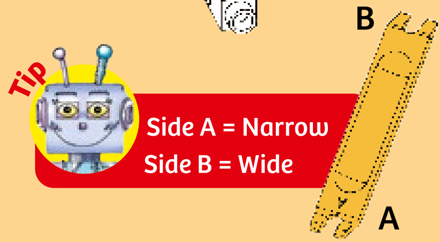

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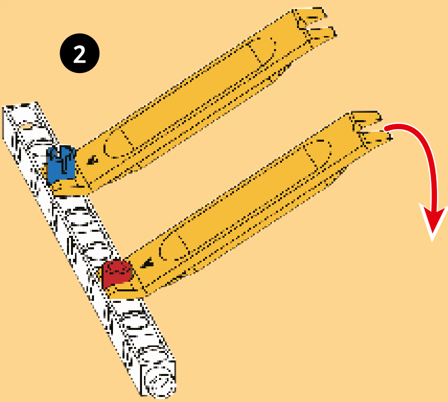

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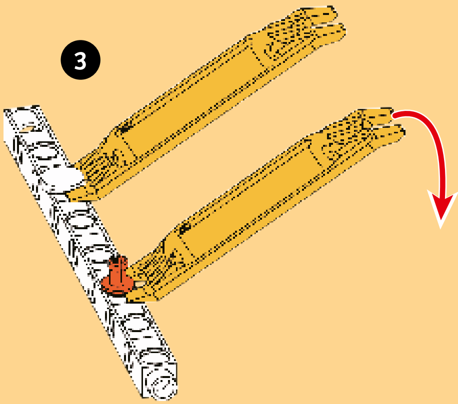
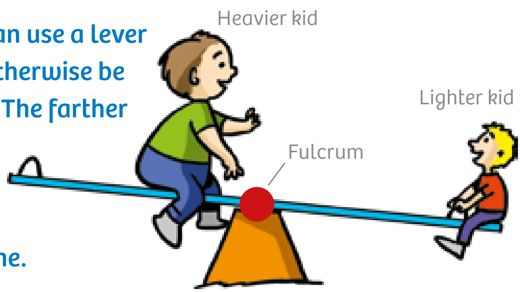


WHAT'S HAPPENING?

It's easier with a lever! You can use a lever to move a load that would otherwise be too heavy for your strength. The farther away from the fulcrum you push, the easier it is. So a long lever can lift a heavier load than a short one.



Seesaw

YOU WILL NEED

+ 8 Marbles
+ Glue

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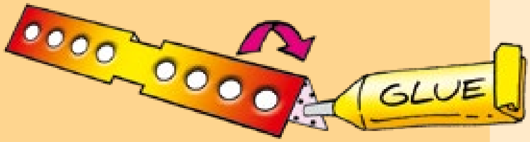

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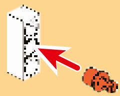
2x



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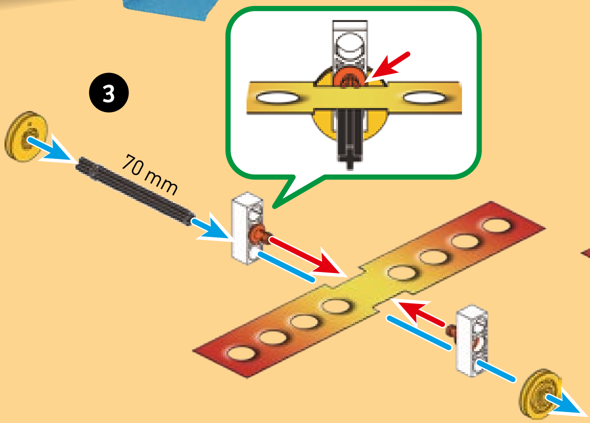

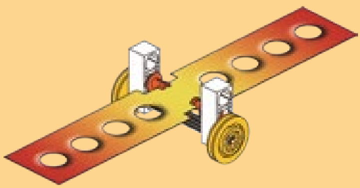

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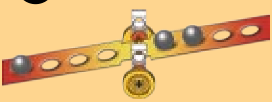

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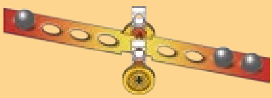

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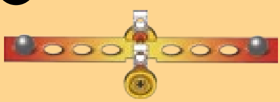


WHAT'S HAPPENING?

A seesaw will tip downward on the side with the greater weight. Both the weight of the objects on the seesaw and their distance from the center fulcrum point are important. The farther a weight is from the fulcrum, the greater its effect, or force.

EXPERIMENT 3

Muscle kids

YOU WILL NEED

+ 2 big wooden or plastic spoons
+ 2-3 meters of thin rope or cord
+ A parent or adult helper

1

2

Set up the experiment as shown. Hold the rope taut and ask your father, mother, or other helper to pull the spoons apart. Then pull on the string. Who is stronger: You or your assistant?

WHAT'S HAPPENING?

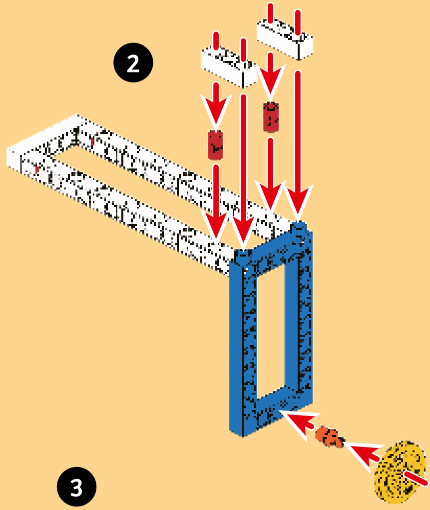
Magic powers? No, it's an engineering trick! An important principle in engineering is that you can reduce the amount of force by applying it over a longer distance. When you wrap the rope around the spoons, you increase the length of rope, but decrease the force needed to pull the spoons together.

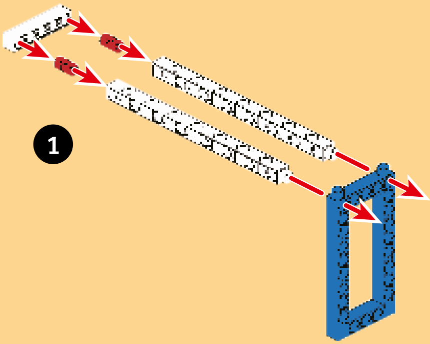
EXPERIMENT 4

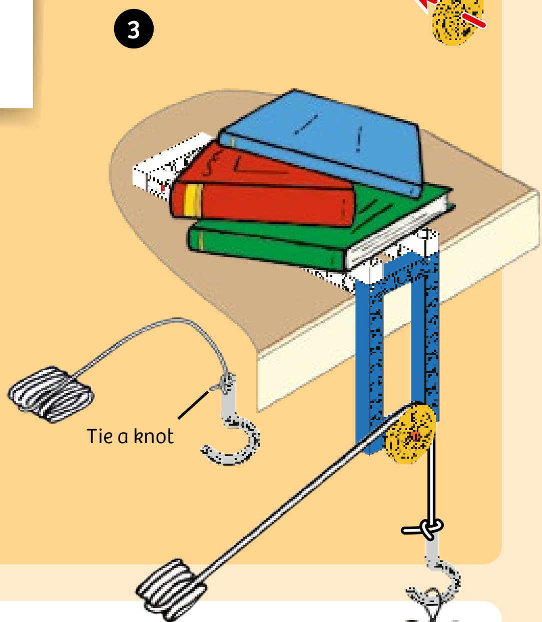
Pulley hoist

YOU WILL NEED

+ Thick books for weights
+ A toy to act as the load (e.g. small sand pail)







WHAT'S HAPPENING?

By pulling down on the string, you lift the bucket up. The pulley changes the direction of the force. Normally, you have to pull upward to lift something up. This pulley doesn't reduce the force needed, but it is still a helpful tool. For example, a painter can use it to lift a bucket up to the top of his scaffolding.

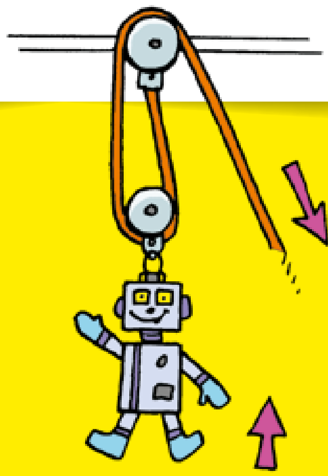
CHECK IT OUT

Excavator

A lever is a simple machine — because it alters a force so that useful work can be done with it. Levers often form parts of larger and more complicated machines. The arm of an earth-digging excavator, for example, is a lever.

Using more than one pulley

You can save effort by working with several pulleys. The rope runs back and forth between the pulleys, like in your experiment with the two spoons! With a pulley system, you need a longer rope and you have to pull farther, but on the other hand you don't need as much force. A pulley system with multiple pulley wheels is called a block and tackle.



Strong Cranes

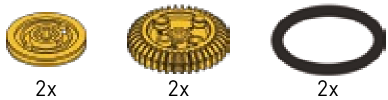
A crane hook is suspended from a block and tackle pulley system. A crane at a construction site can lift heavy beams and large walls.

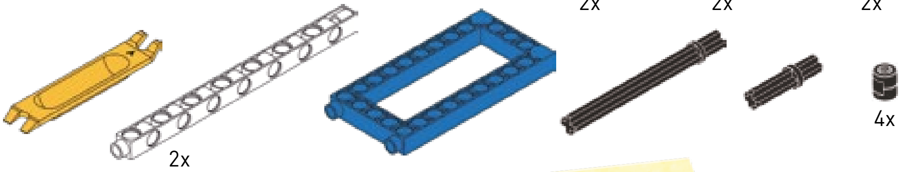
Engineering on Land

EXPERIMENT 5

Speedy race car

YOU WILL NEED





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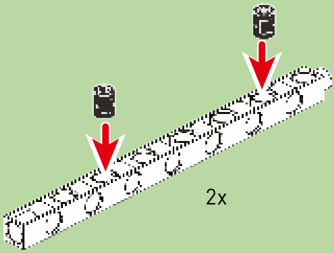

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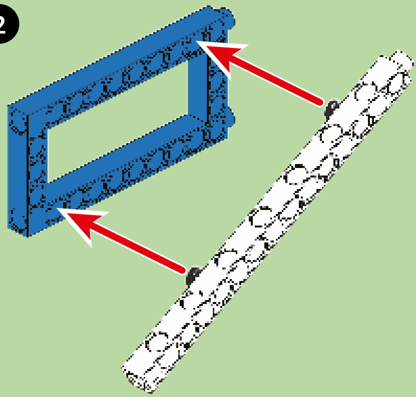

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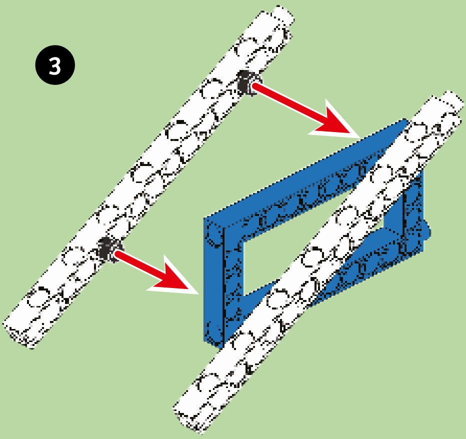

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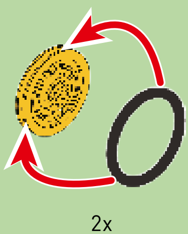
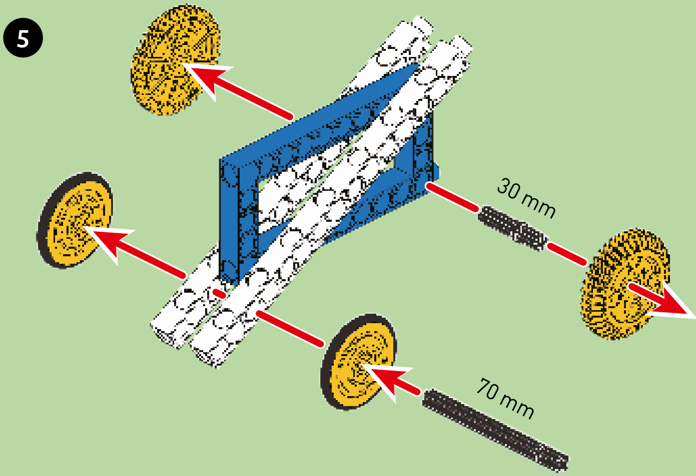
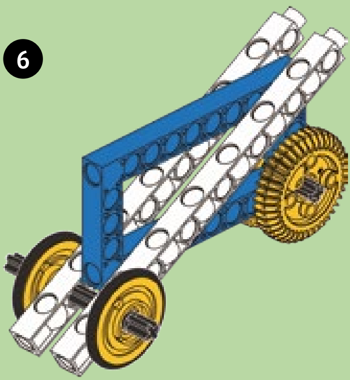






Tip Before racing the car, check to make sure all the wheels turn freely!

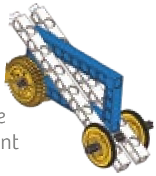
WHAT'S HAPPENING?

Push your car to make it race across the floor or table! It goes pretty fast — but not by itself. You have to push it to make it go. Or you could let it race down a steep hill. See the experiment on the next page!

EXPERIMENT 6

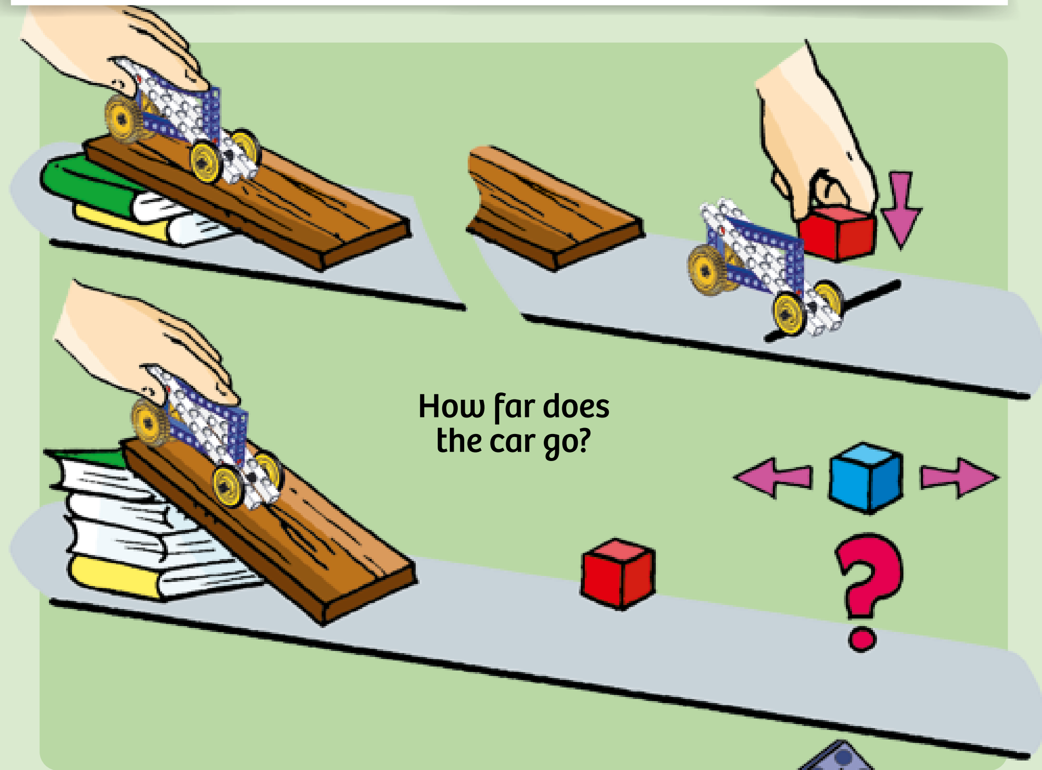
Ramp racing

YOU WILL NEED



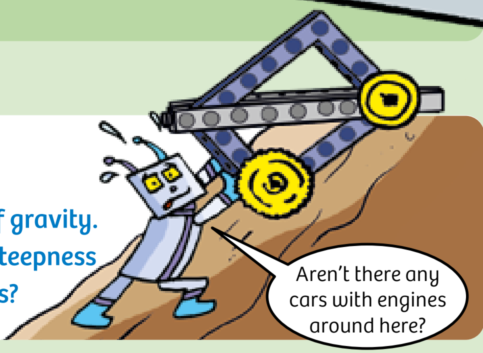
Car from the last experiment

- Wooden board
- Several books
- Toy blocks for marking distance



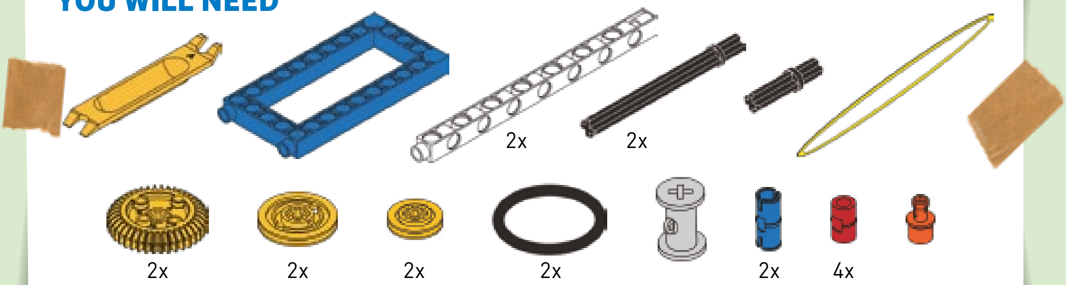
WHAT'S HAPPENING?

The car rolls down the ramp because of gravity. Engineering challenge: How does the steepness of the ramp affect how far the car goes?



Wind-up car

YOU WILL NEED



+ Scissors

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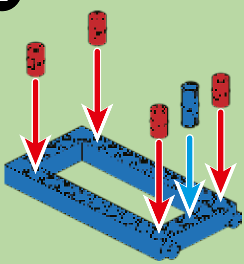

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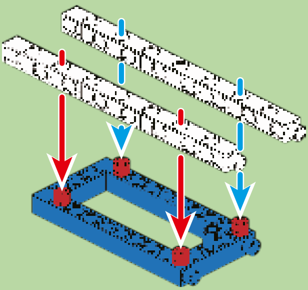

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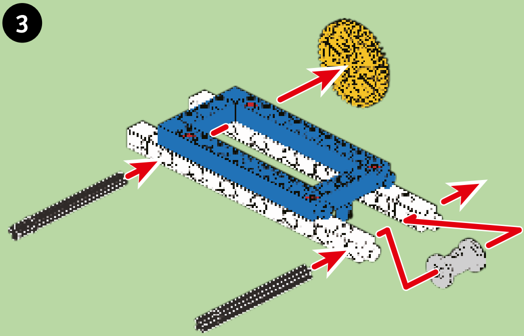

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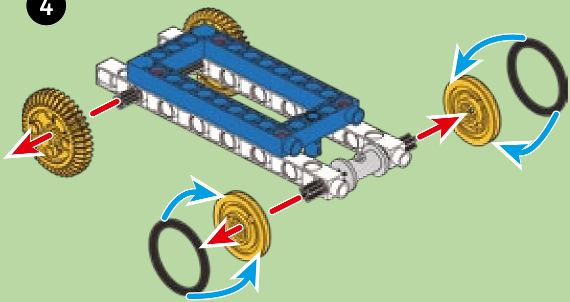

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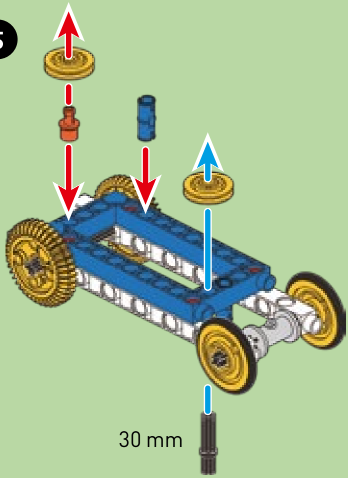

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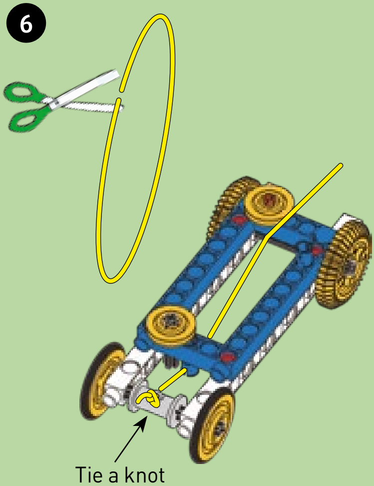

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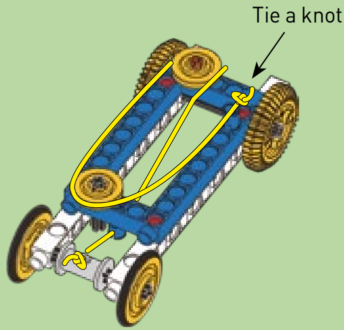

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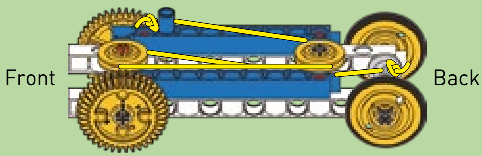
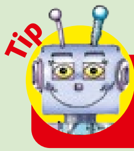
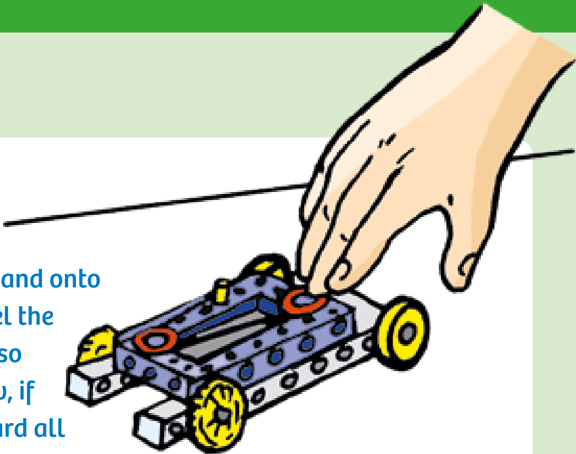




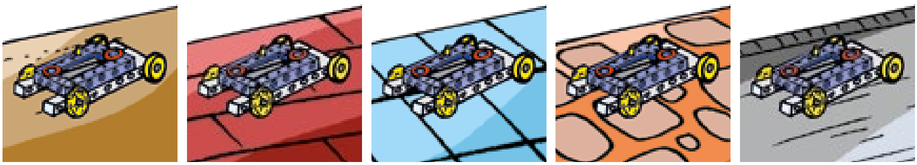
Check to make sure all the wheels turn easily!

WHAT'S HAPPENING?



Pull your car backwards along the ground. That will wind the rubber band onto the spool and stretch it. Can you feel the resistance get stronger? Then stop, so the rubber band doesn't break. Now, if you let go of the car, it drives forward all by itself! When you wind it up — in other words, when you stretch the rubber band — you store energy in the car. When you let it go, this energy is released, and the car drives until the rubber band is slack again.

Where does your car drive best? Try out different surfaces!

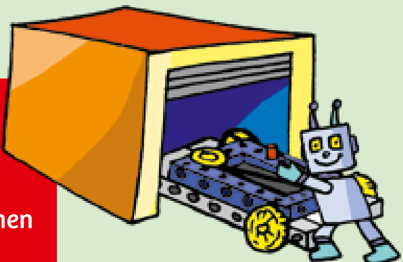


Tip

If the wheels slip, check these things:
Did you install the black rubber tires on the rear wheels? Is the rubber band winding up correctly around the spool or is it slipping?
When starting, give the car a little push to get it going. Before you wind up the car, the rubber band should sit quite loosely. If necessary, you can move the joint pin to another hole.

Tip

Rubber bands can change and become brittle when exposed to light!

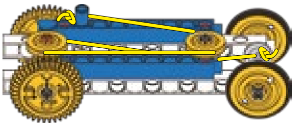


Put your car in a garage!

EXPERIMENT 8

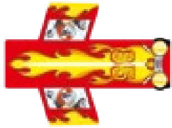
Auto body

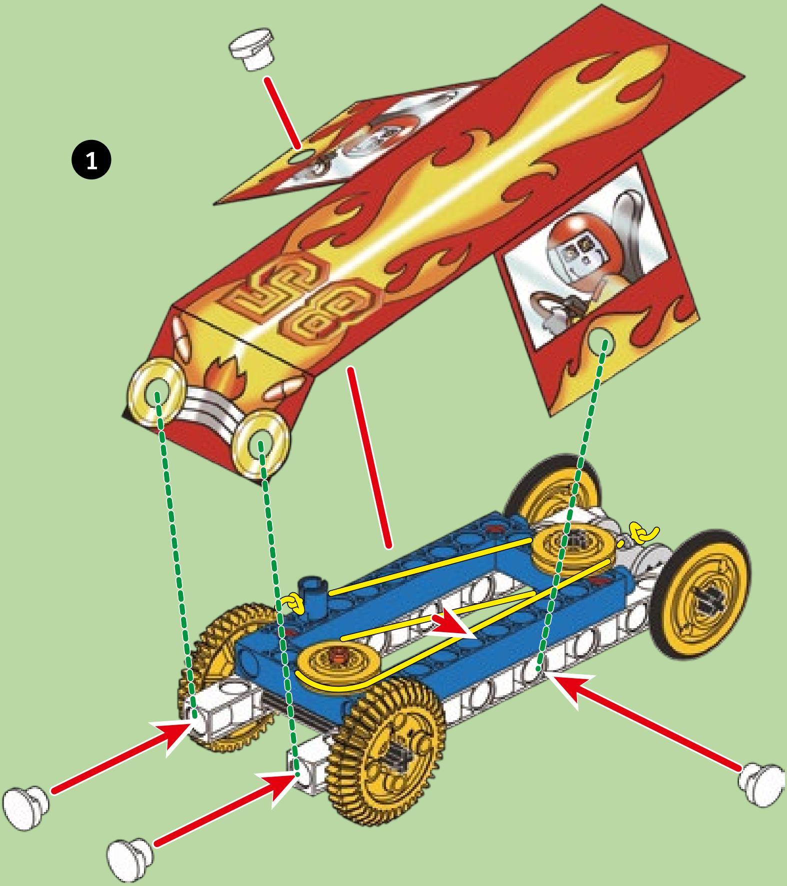
YOU WILL NEED



Car from the last experiment

4x





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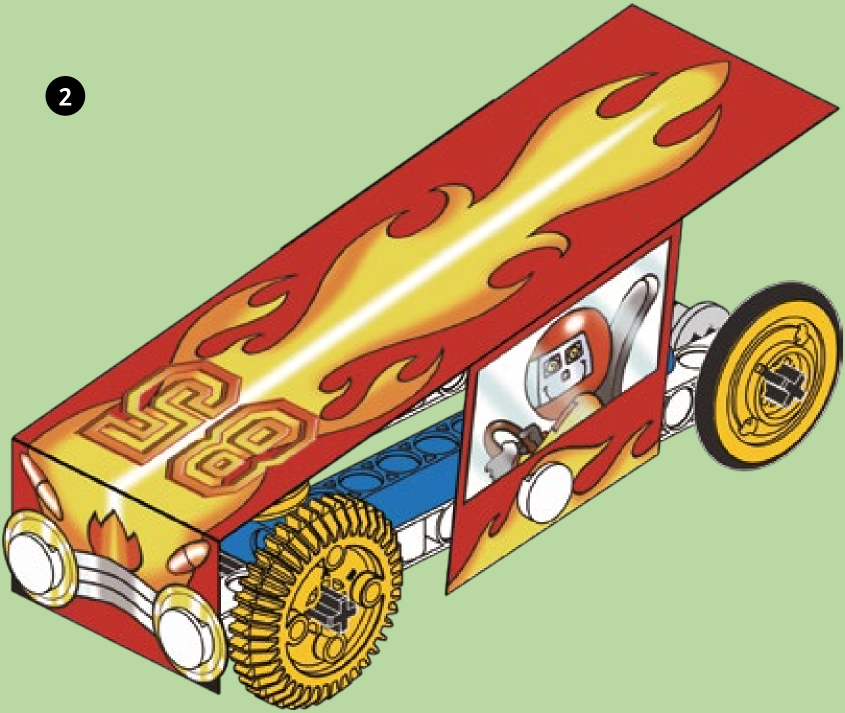
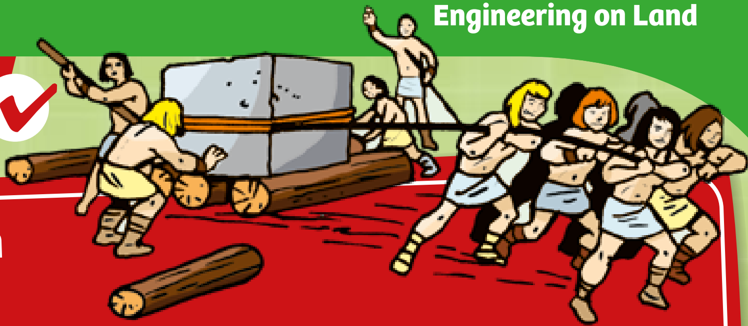


WHAT'S HAPPENING?

Doesn't your car look so much cooler with its outer body covering? The shape of a car's body is important not just for its good looks. A tall, boxy car body has a greater air resistance — and thus uses more fuel — than a low, flat car body.

CHECK IT OUT

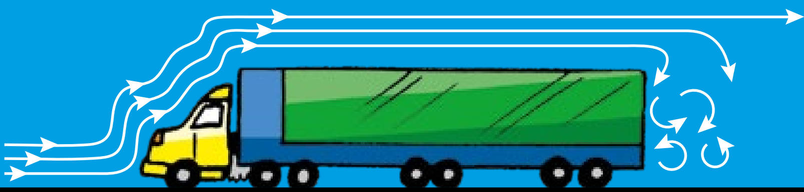


The invention of the wheel

The invention of the wheel was a revolutionary development in human history. Wheels allow heavy loads to be transported with ease from one location to another. Before wheels existed, people did things like laying logs on the ground, placing the load on them, and pulling it forward with ropes. The logs had to be continually moved from the back to the front in order to pull the load a few more meters. A laborious task, for sure!

AIR RESISTANCE

The size and shape of a vehicle's body determine its air resistance. A tall truck with lots of corners and edges has more resistance. Racing cars, on the other hand, are low to the ground and expose only a small surface area to the wind, so the air glides easily around their streamlined shapes. That is one reason they can go so fast.



Not a Streamlined Shape

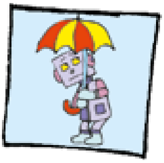
Streamlined Shape

Engineering in the Air

EXPERIMENT 9

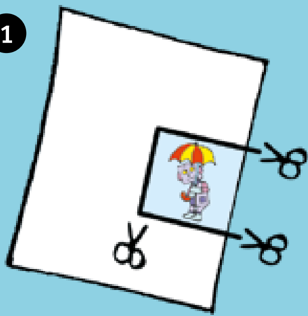
Water glass trick

YOU WILL NEED



- Scissors
- Glass
- Water

1



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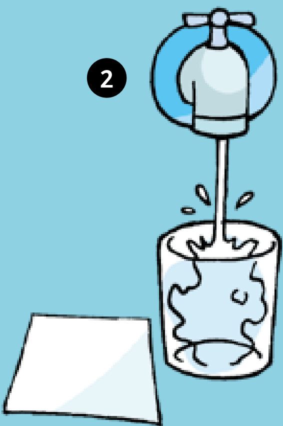

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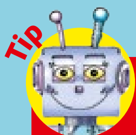


The paper has to cover the glass well all the way around and extend a little beyond the glass's edge!

4

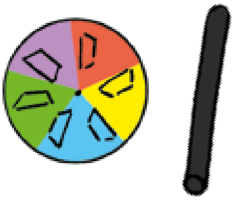
WHAT'S HAPPENING?

Air is strong! You can't see it, but it's there — and it pushes against the paper from below. Even though you have pulled your hand away, the paper won't fall down, and the water stays in the glass.

EXPERIMENT 10

Puff-powered wheel

YOU WILL NEED



+ Thumbtack

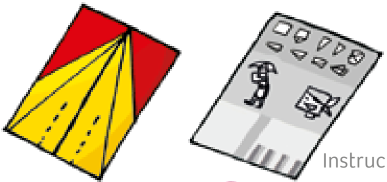
WHAT'S HAPPENING?

You won't need to turn this wheel with your fingers — it is propelled by air! If you hold the straw so that you are blowing directly onto the flaps, the wheel will start turning. The stronger you blow, the faster it turns.

EXPERIMENT 11

Glider

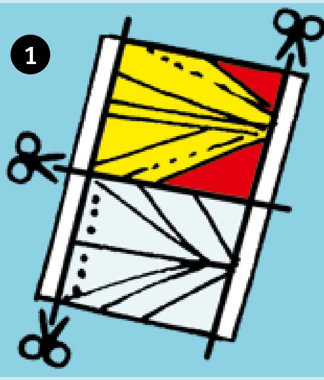
YOU WILL NEED



Instructions

+ Scissors

1



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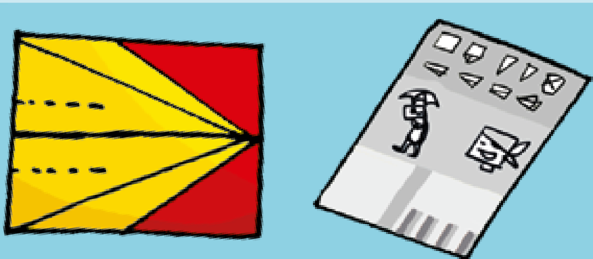
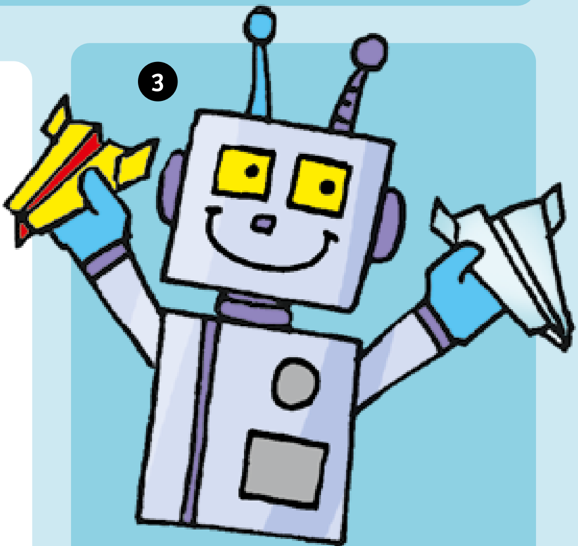


WHAT'S HAPPENING?

Hold your glider tightly by the bottom, throw it forward, and let it go!

3

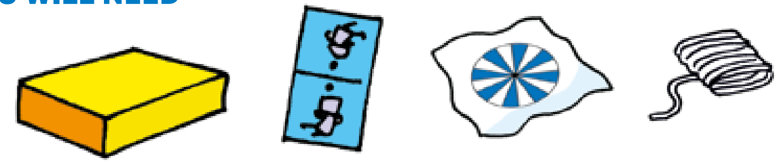


This is how the finished gliders look. You will find the assembly instructions on a separate sheet.

EXPERIMENT 12

Parachute

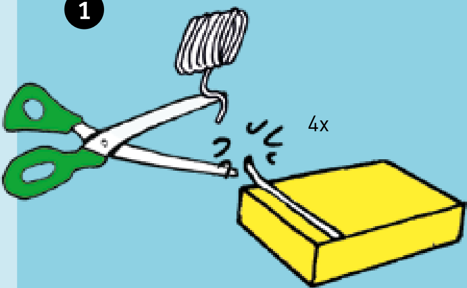
YOU WILL NEED



The kit box

+ Scissors

1



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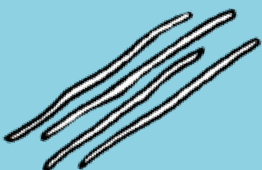

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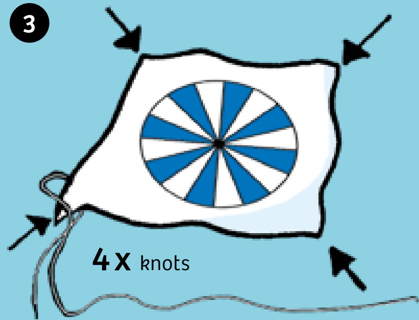

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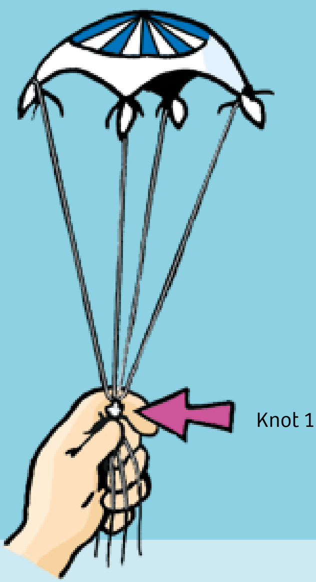
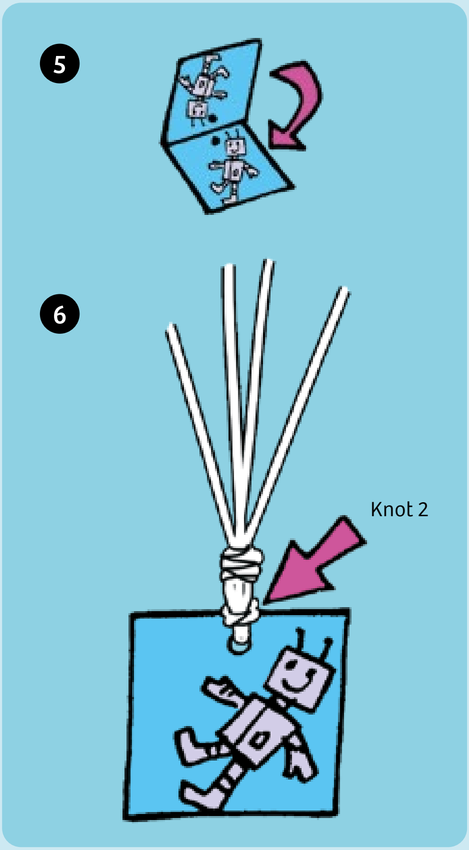
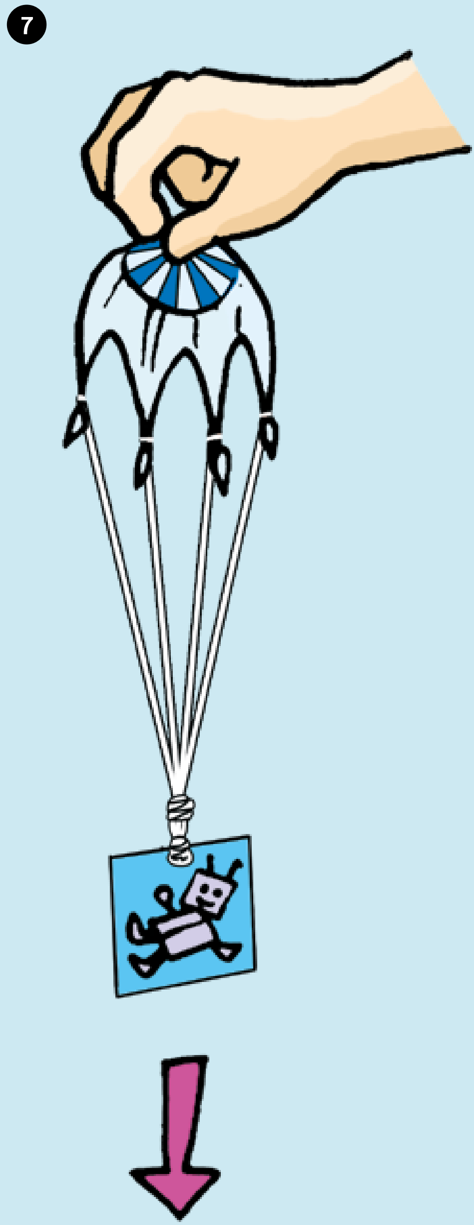






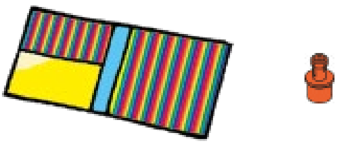
WHAT'S HAPPENING?

Hold the parachute by the center of the top and let it go. You can also toss it upward in the air a little for a longer falling time. The parachute will spread out and the skydiver will glide softly to Earth, with the air beneath the chute acting as a brake. Without the parachute, it would fall to the ground like a stone.

EXPERIMENT 13

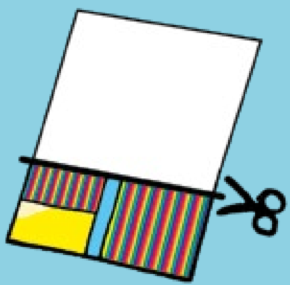
Helicopter

YOU WILL NEED



+ Scissors

1



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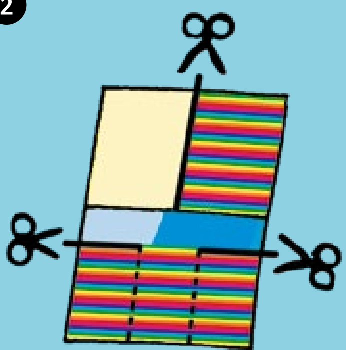

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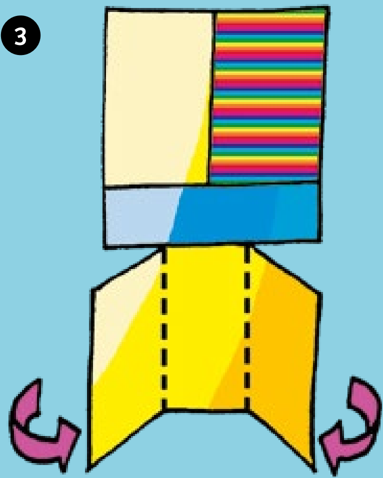

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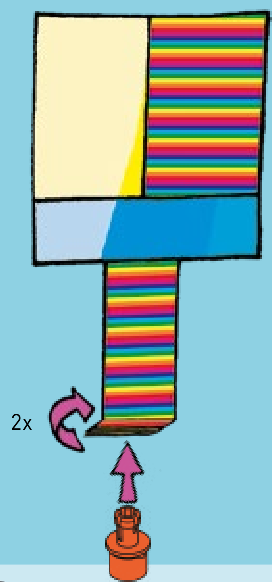
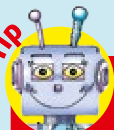
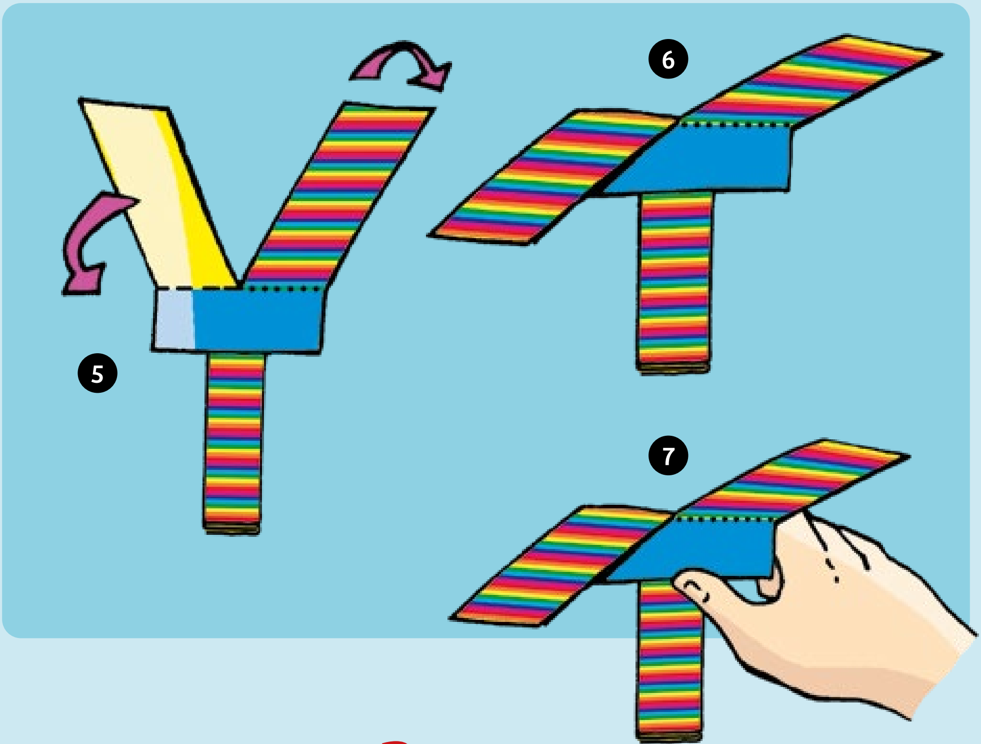




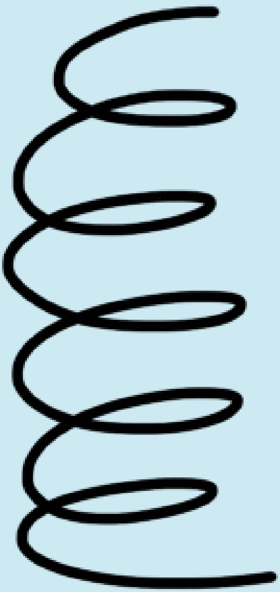
Tip

Dotted lines ••••• remain visible after folding, dashed lines ––––– disappear inside the fold!



WHAT'S HAPPENING?

Hold your helicopter just under the blades and then let it go. It will start to rotate, and will then glide slowly to the ground.



Well rounded

Did you know that **helicopters** can fly sideways and backward, in addition to up and down? They can even stand still in the air! In addition, a helicopter does not need a runway when taking off or landing, since it can move straight up and down. Because it is so agile, it is often deployed in difficult terrains: to transport the injured after an accident, for mountain rescues, and to save people at sea.

Electrical power from the wind

Did you know that people use wind to generate electricity? In wind farms, the wind is used to drive giant **wind turbines.** The kinetic energy of these windmills is converted into **electrical energy.** So in the beginning, there's wind — and at the end, you get electricity coming out of the wall socket!

CHECK IT OUT

SPACE SCIENTISTS

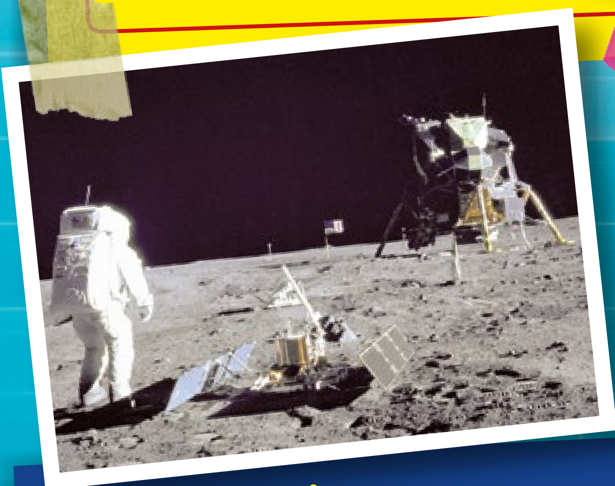
If you want to fly into space, you need a rocket ship instead of an airplane. From 1981 to 2011, the NASA Space Shuttle was used to transport people to and from space. The shuttle takes off like a rocket but returns to Earth like a plane. A parachute helps it slow down.

The shuttle flew into space and back 135 times before it was retired in 2011. At the beginning of space travel, that was not possible. A rocket could take off into space, but after its first use it couldn't be used again.

The Space Shuttle was replaced by the Space Launch System to bring astronauts and materials into space.

Take-off

Landing



Trip to the Moon

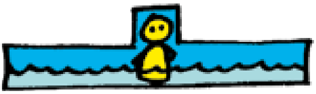
Did you know that the American Neil Armstrong was the first man on the moon? In 1969, he landed there with his rocket and, as he set foot on the moon's surface, said the famous words: "That's one small step for [a] man, one giant leap for mankind."

Engineering in the Water

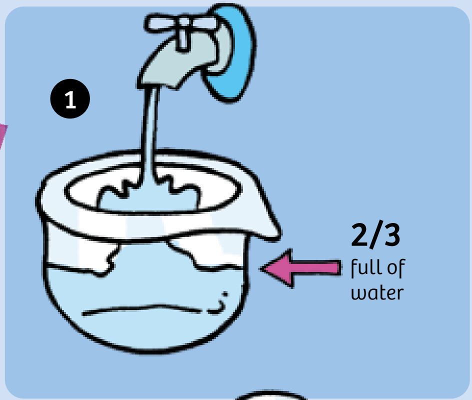
EXPERIMENT 14

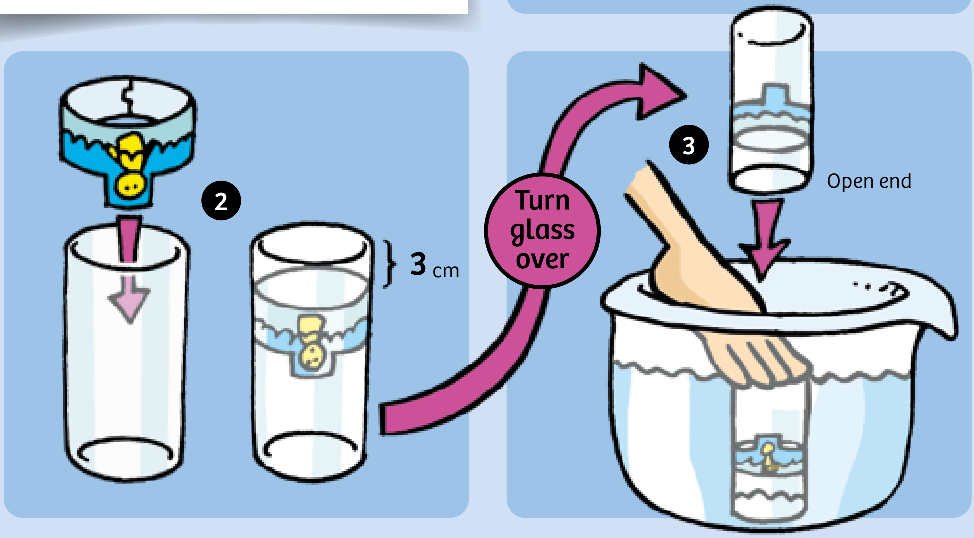
The diving bell

YOU WILL NEED



+ Drinking glass with straight sides
+ Mixing bowl (plastic)
+ Water



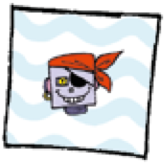


WHAT'S HAPPENING?

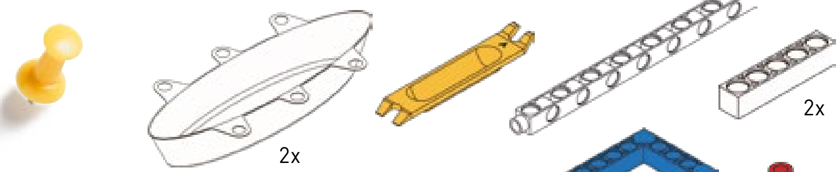
It's true that your glass looks empty, but it is actually full — of air! If you hold the open end of the glass straight down, the air can't get out of the glass. It is compressed by the pressure of the water just a little. The robot can go diving and stay dry!

EXPERIMENT 15

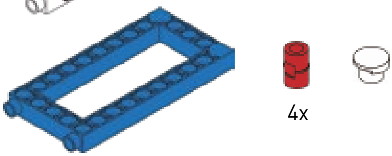
Sailboat



YOU WILL NEED



+ Scissors
+ Sink basin or bathtub
+ Water
+ Captain



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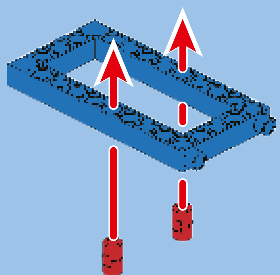

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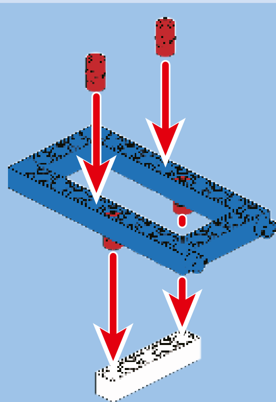

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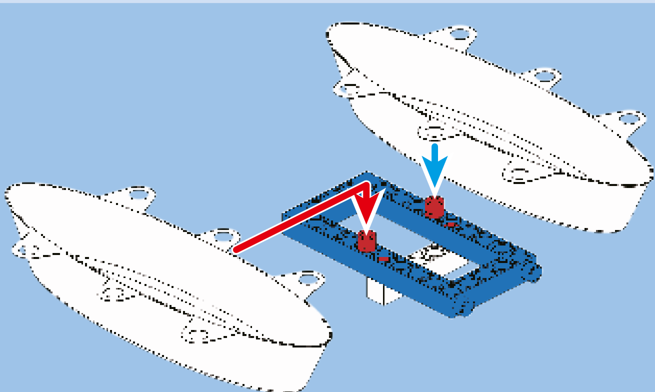

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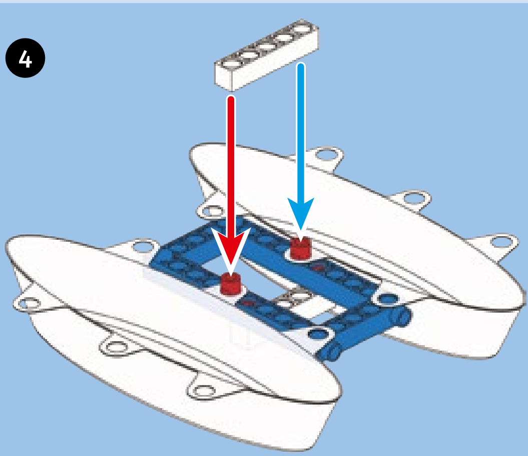

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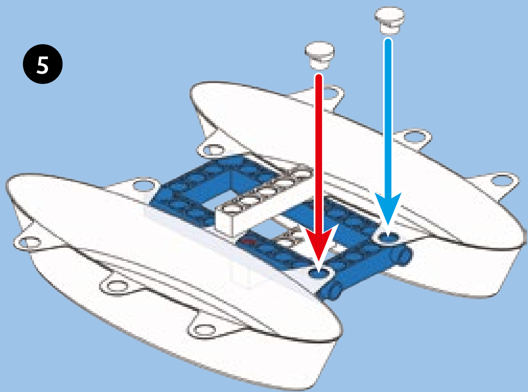

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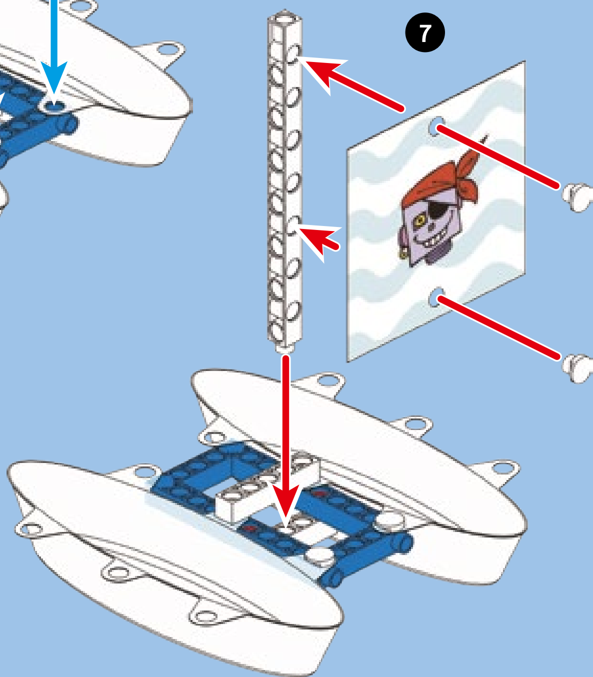
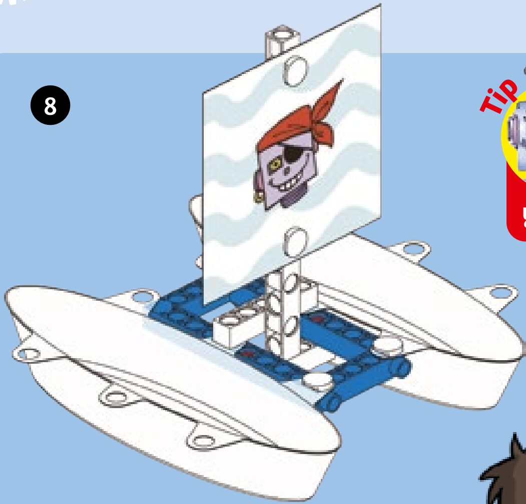


Tip

Always pay attention to the correct alignment of the rods with the holes in them. Count the holes to determined exactly where to place the anchor pins.

8



Tip

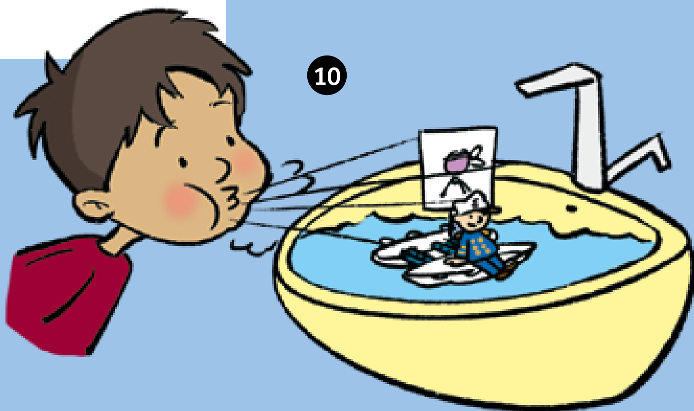
Do you have a captain for your sailboat?

9

WHAT'S HAPPENING?

Blow into the sail from the back and the sailboat will float forward. The air you blow puts pressure on the sail. The pressure is transferred to the mast and hull and pushes the ship forward in the water.

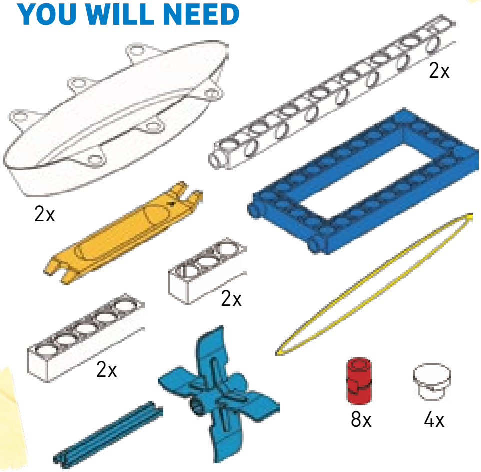
10



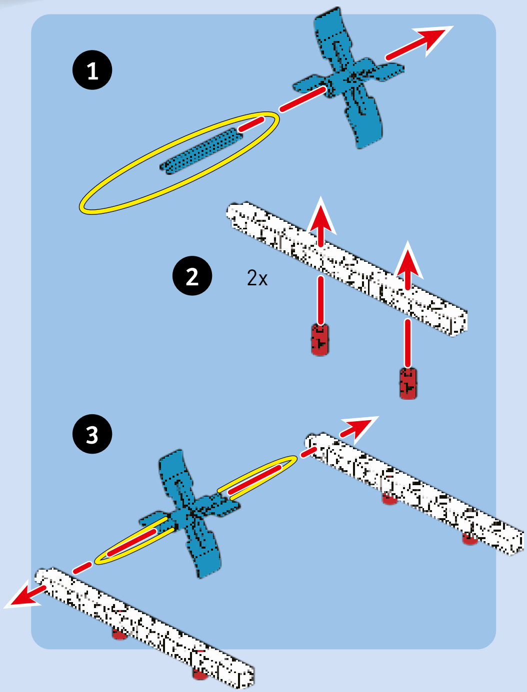
EXPERIMENT 16

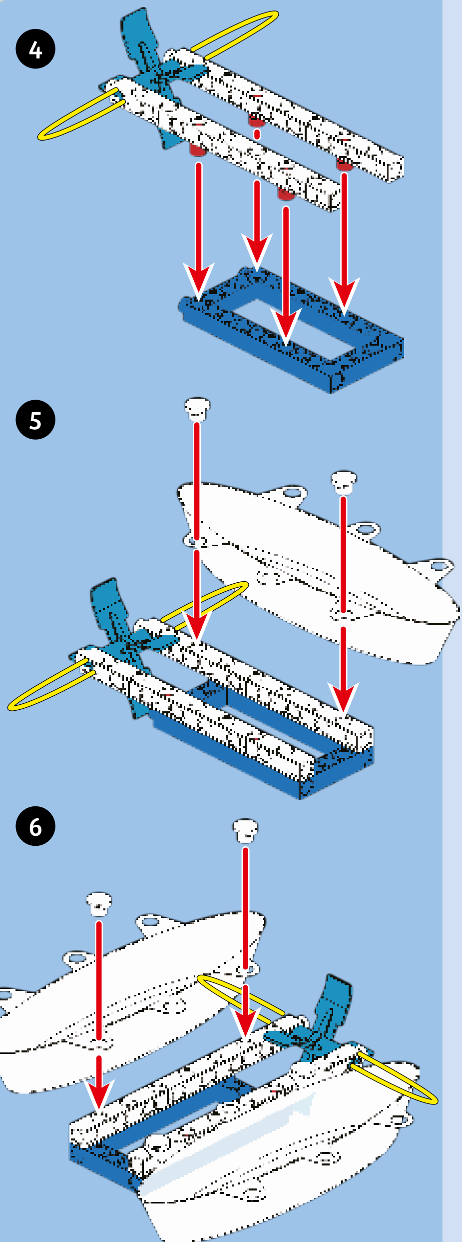
Paddle-wheel boat

YOU WILL NEED



+ Scissors
+ Bathtub
+ Water
+ Captain





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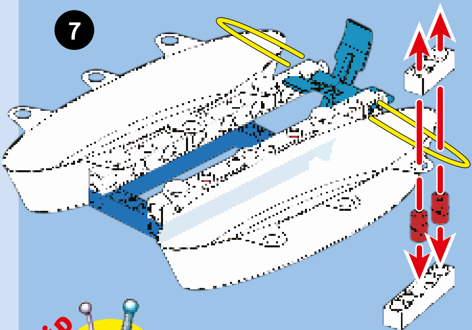
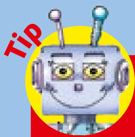
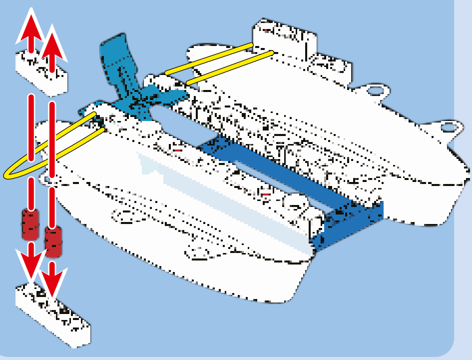




The rubber band should be stretched tight. If the rubber band is very loose or sticks out a lot on the sides, you can shorten it on one or both ends with a knot.

8



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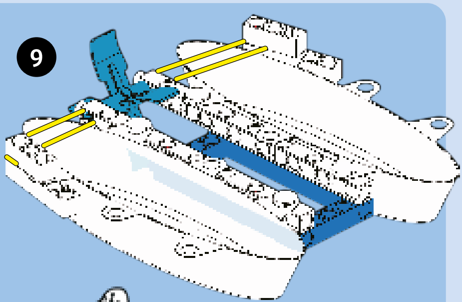


10

11

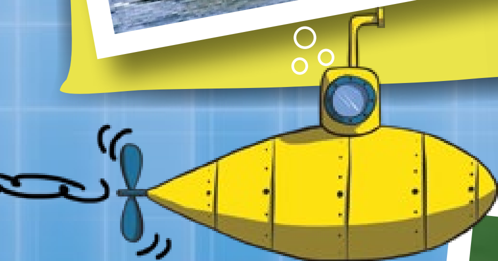
WHAT'S HAPPENING?

Energy is stored up in the wound-up rubber band — just like in the wind-up car. When you let go of the paddle wheel, it starts to turn. The blades of the paddle wheel push the water away at the rear and drive the boat forward.

CHECK IT OUT

Wind from the wrong direction?

Did you know that a sailboat can make its way back to harbor even against a **headwind?** By maneuvering cleverly with the sail adjusted at an angle to the wind, the boat can zigzag its way to its destination.



Submerged

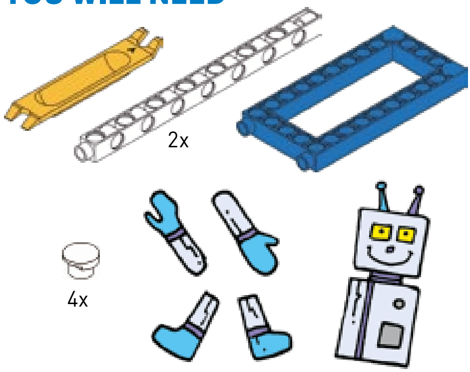
If you want to explore the underwater world you need a submarine! There are even unmanned **robotic submarines:** These have no people on board. A diving robot can dive deeper than normal submarines. They are smaller and more agile, and can take the high pressure deep in the ocean.

Engineering at Home

EXPERIMENT 17

Robot model

YOU WILL NEED



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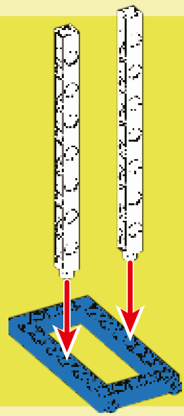

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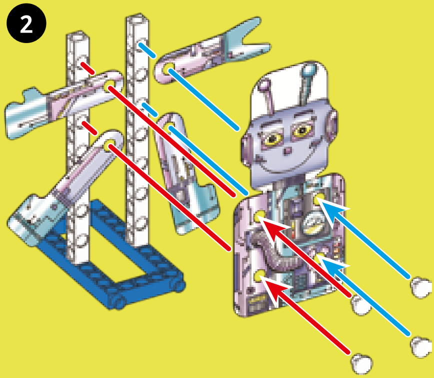

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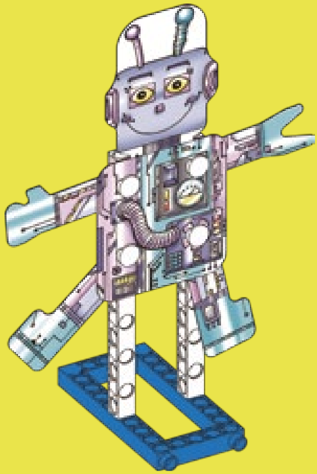
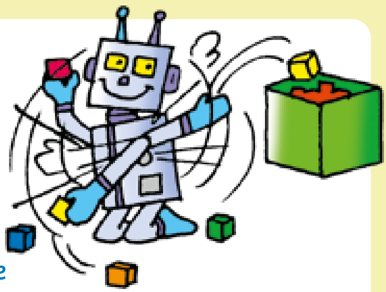


WHAT'S HAPPENING?



Robots are machines, and they can do many kinds of work more quickly and more precisely than humans. We are always astounded by the latest developments in robotics. What won't a robot be able to do in the future? This pretend robot will be happy to be your personal everyday assistant. What would you like him to give you a hand with? Cleaning up your toys? Calculating the number of hours before your next birthday? Or fetching balls off the roof with his grabbers?

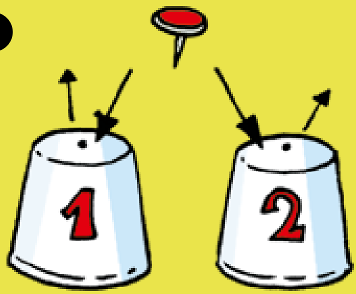
EXPERIMENT 18

String telephone

YOU WILL NEED

- + 2 small empty yogurt containers
- + Thumbtack

1



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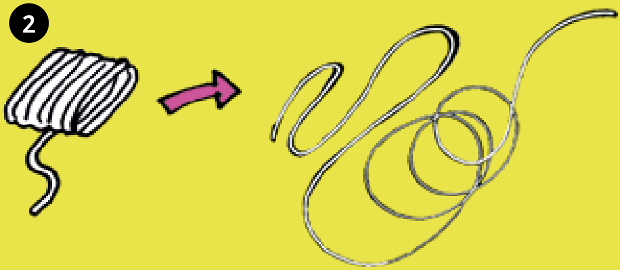

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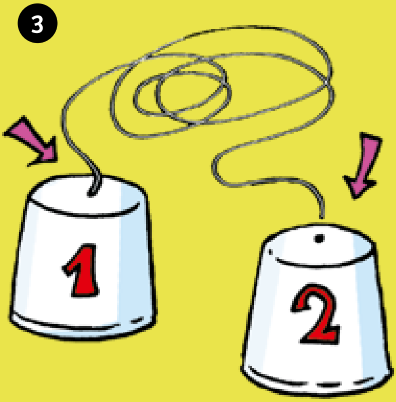

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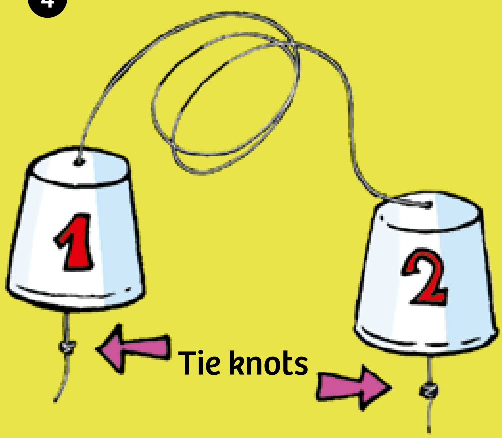
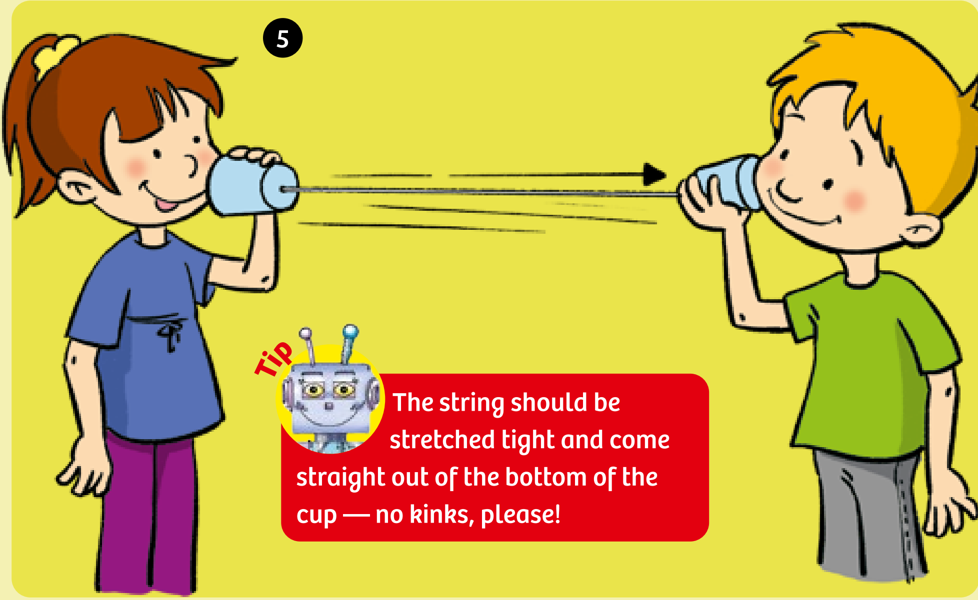
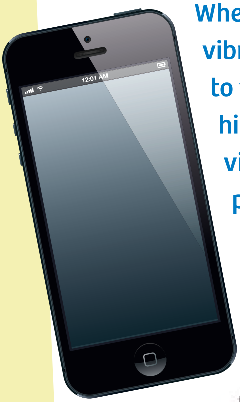




Tip The string should be stretched tight and come straight out of the bottom of the cup — no kinks, please!

WHAT'S HAPPENING?



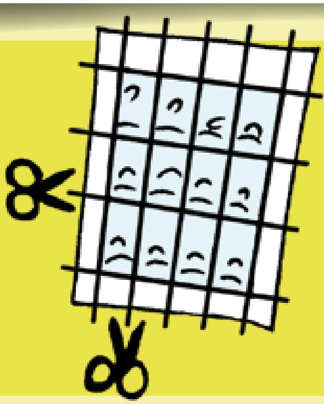
When you speak into the plastic cup, the bottom of the cup starts to vibrate. The vibration is transferred to the string, which also starts to vibrate. The louder the sound, the stronger the vibration. The higher the sound, the faster the vibration. Then, it passes its vibrations on to the floor of the other cup, where the other person can hear you. Real telephones do not transmit vibrations through a string, but when you speak into a telephone mouthpiece, the sound vibrates a metal plate, which creates electrical signals which are then transmitted through wires or wireless signals.

Flip book TV

YOU WILL NEED

+ Scissors

1



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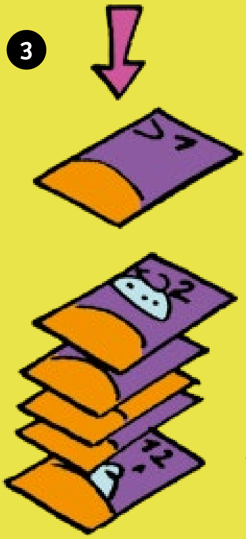

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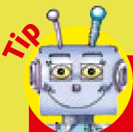
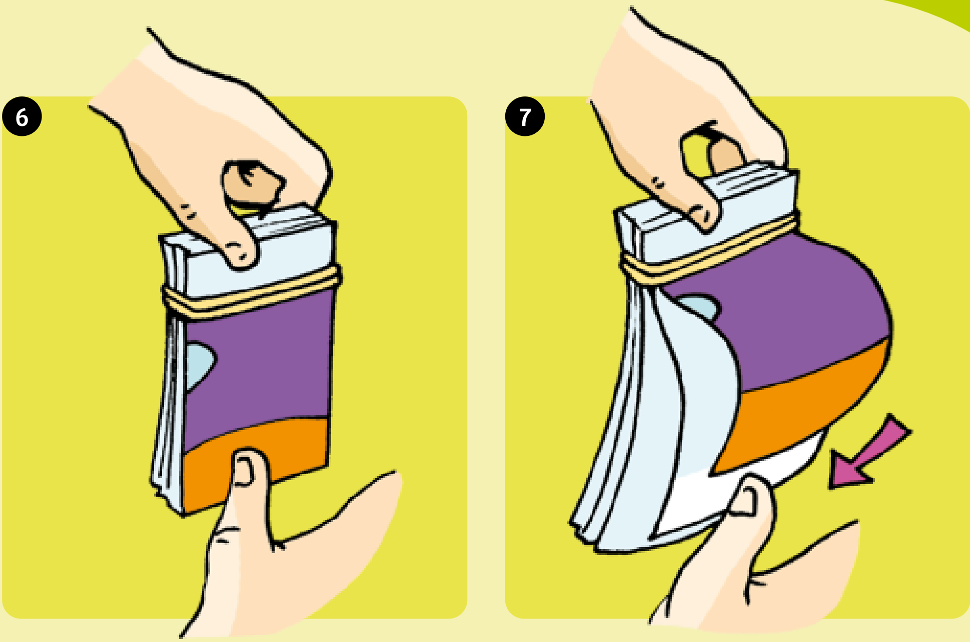
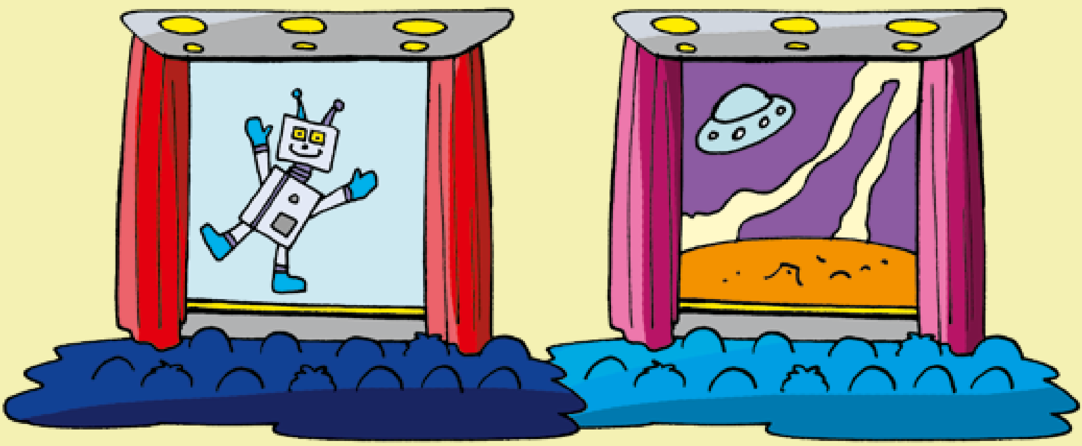


Tap the edge of the stack of cards against a table before you attach the rubber band, so all the cards are evenly lined up.



WHAT'S HAPPENING?

Just like a real movie, the flip book displays lots of individual pictures, one after the other. Each picture changes a little bit from the one before it. When you run your thumb along the edge, you quickly flip through all the pictures in a row. Your eye and brain are too slow to perceive the individual images, so they flow together into one continuous image that appears to move.

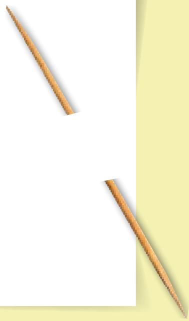


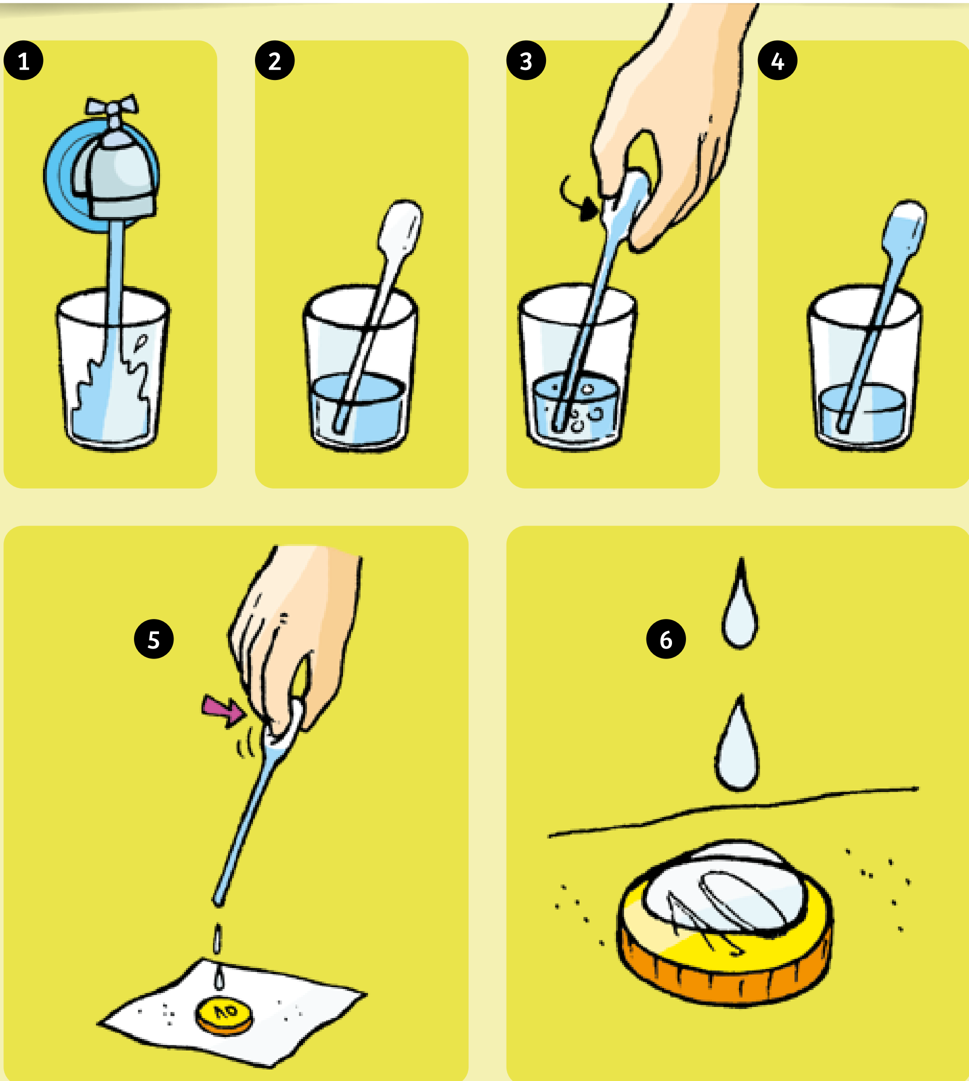
EXPERIMENT 20

Mound of water

YOU WILL NEED

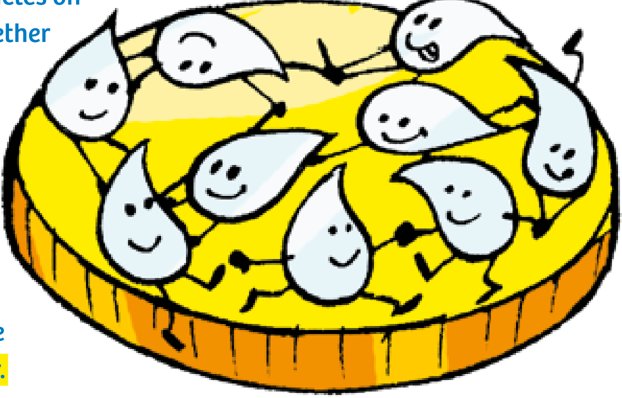
- Coin
- Plastic cup
- Water
- Paper towel





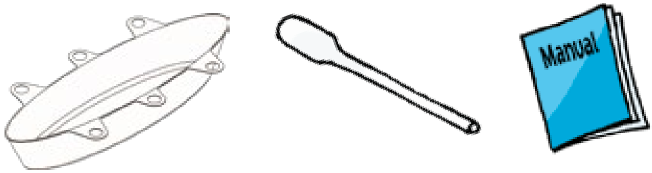
WHAT'S HAPPENING?

Water is composed of lots of little particles that you can't see. But they have an interesting property: They attract one another — as if they were all latched together. When you add a water drop to the mound of water, its particles latch onto the other water particles on the coin. They attach together so strongly that the surface of the water bulges up and none of the water flows away until a certain point when there is too much water. This attraction force is referred to as the surface tension of water.

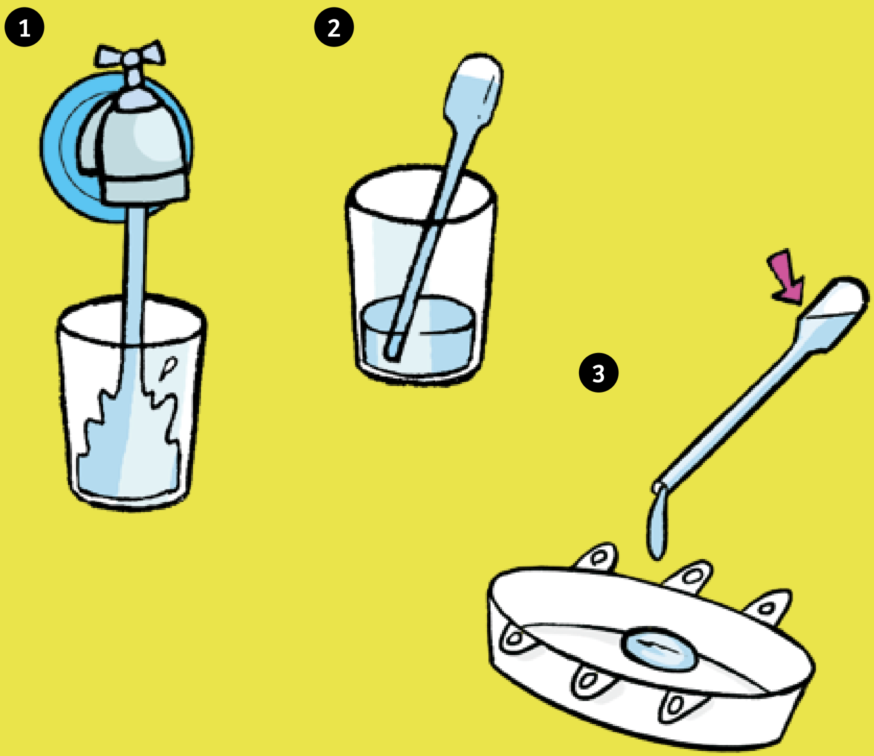


Water-drop lens

YOU WILL NEED



- Plastic cup
- Water
- Paper towels for drying



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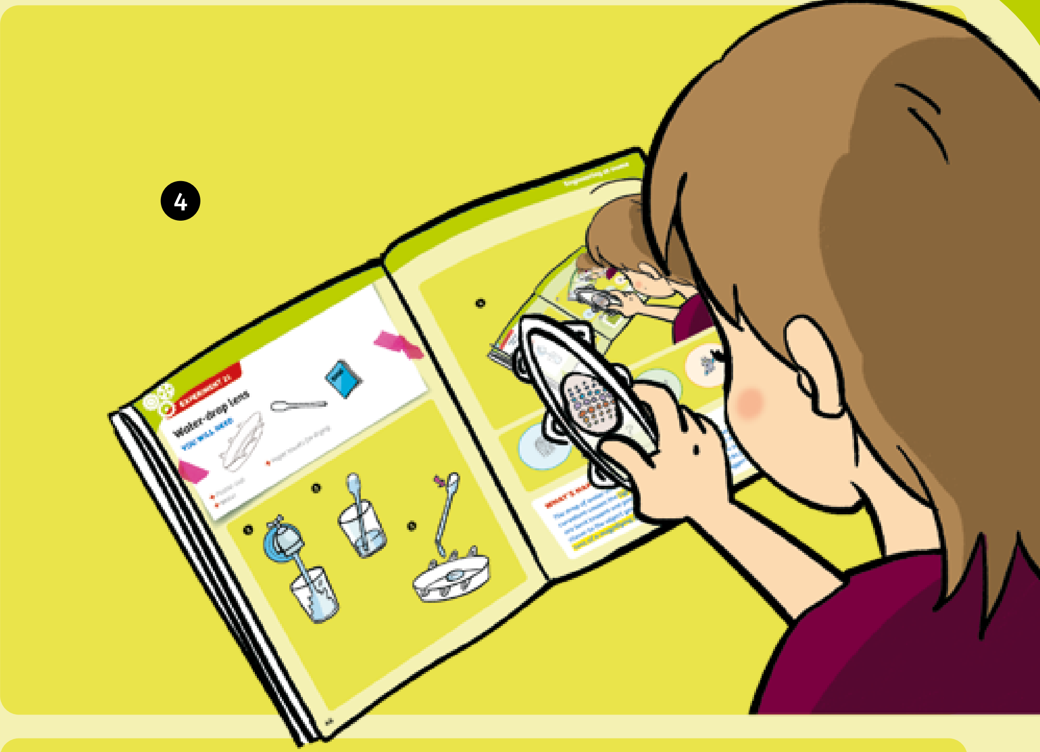
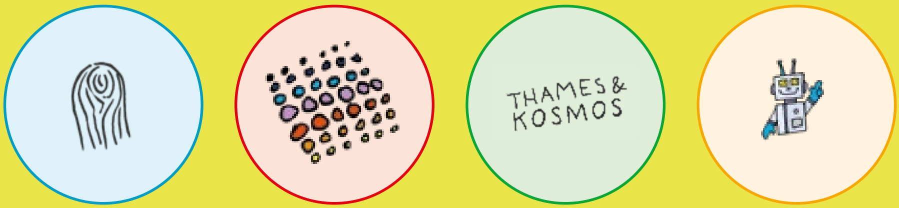




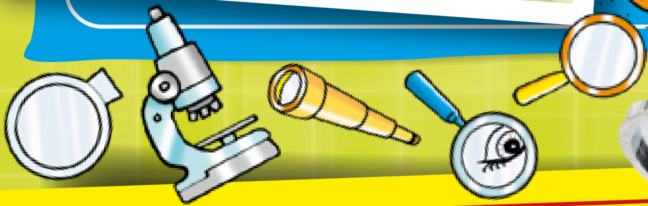
WHAT'S HAPPENING?

The drop of water on the clear boat hull has a semicircular, domed shape. This curvature causes the light waves passing through it to change direction. They are bent toward one point — the focal point. To your eye, this is like moving closer to the object you're looking at. The drop of water works just like the lens of a magnifying glass and makes small things look bigger!

CHECK IT OUT

Don't drink these lenses!

The lens of a magnifying glass has the same shape as the mound of water in the last experiment. In a magnifying glass, the lens is made of glass, so you can't drink it!



Microscope

A microscope is like a really strong magnifying glass. It contains several lenses, so it can attain a much greater magnification. A magnifying lens shows objects 10 to 20 times larger, but a microscope can magnify things by more than 1,000 times! The record is held by the electron microscope, which works with electron beams instead of rays of light. It provides images that are magnified over 1,000,000 times!

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